Constructing an AIRS Climatology for Data Visualization and Analysis to Serve the Climate Science and Application Communities

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Climate science and application communities are invited to take advantage of Giovanni to explore the 14-year long AIRS Version 6 products at GES DISC: http://giovanni.sci.gsfc.nasa.gov/giovanni/

Abstract

The NASA Goddard Earth Sciences Data and Information Services Center (GES DISC) is the home of processing, archiving, and distribution services for sounders: the present NASA Aqua Atmospheric Infrared Sounder (AIRS) mission and the succeeding NOAA SNPP* Cross-track Infrared Sounder (CrIS) mission. The AIRS mission is entering its 15th year of global observations of the atmospheric state, including temperature and humidity profiles, outgoing longwave radiation, cloud properties, and trace gases. The GES DISC, in collaboration with the AIRS Project, released data products from the Version 6 algorithm in early 2013. Giovanni, a Web-based application developed by the GES DISC, provides a simple and intuitive way to visualize, analyze, and access vast amounts of Earth science remote sensing data without having to download the data. Most important variables from the Version 6 AIRS product are available in Giovanni.

We are developing a climatology product using 14 years of AIRS retrievals. This climatology is defined as the multi-year (here 14-year) mean of monthly products. The study can be a good start for the long-term climatology from sounders: AIRS and the succeeding CrIS. Our presentation will show the impacts to this climatology product by different averaging methods. This climatology can serve the climate science and application communities in data visualization and analysis, which will be demonstrated using a variety of functions in Giovanni, such as climatology plots and anomaly analysis.

* Suomi National Polar-Orbiting Partnership

Weighted vs Unweighted Monthly Climatology

The AIRS monthly standard retrieval product (AIRX3STM) is a **weighted** average of the daily means (AIRX3STD), where the counts of successful retrievals in a 1x1 degree cell for each day serve as weights. However, AIRS temperature retrieval succeeds in conditions with cloud cover less than 90%. Thus, the standard monthly product is technically an estimator that is slightly biased toward fair weather conditions. The randomness of the sampling, and hence applicability of weighted average, then can be questioned. Considering the counts will consistently weigh in favor of less-cloudy conditions, the problem may become more significant over multi-year climatological estimates.

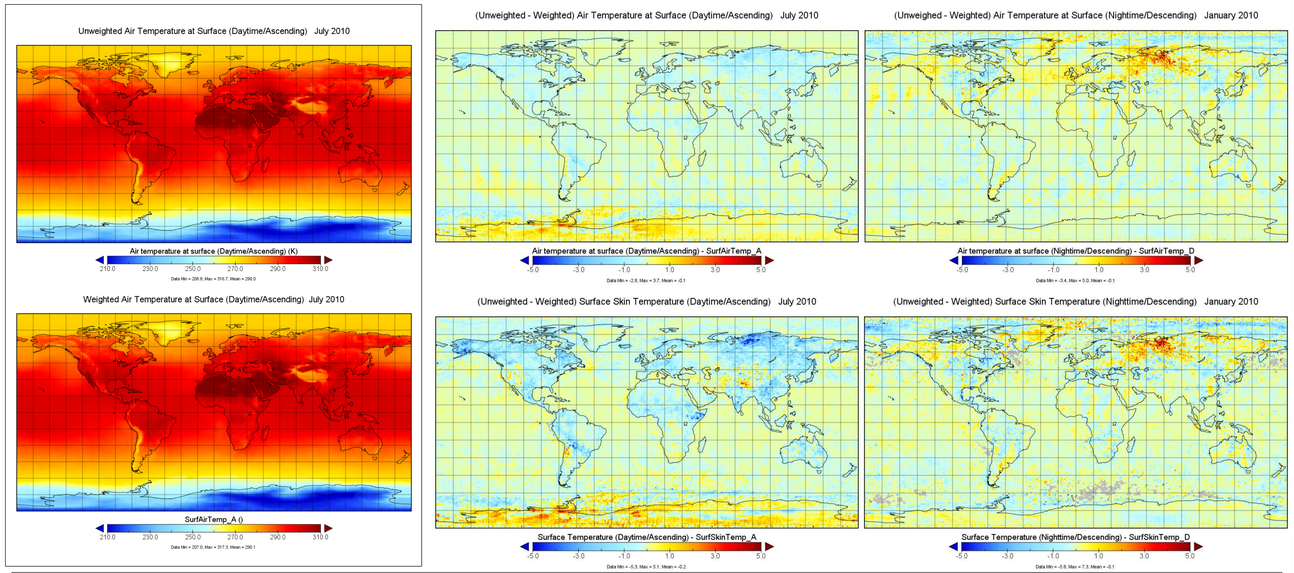
The simplest way to alleviate this problem is to produce **unweighted** averages instead, where all days and months have equal weight. For the purposes of this analysis we use the “Time Averaged Map” function in Giovanni to produce **unweighted** monthly and multi-year climatology estimates, and compare them against the standard monthly, and derived **weighted** climatology, estimates.

Datasets and Variables

The datasets used for this work are AIRS Version 6 standard retrieval monthly product (AIRX3STM) and daily product (AIRX3STD) over 14 years: from September 2002 to August 2016. The surface air and surface skin temperatures for daytime/ascending and nighttime/descending nodes are selected for this study.

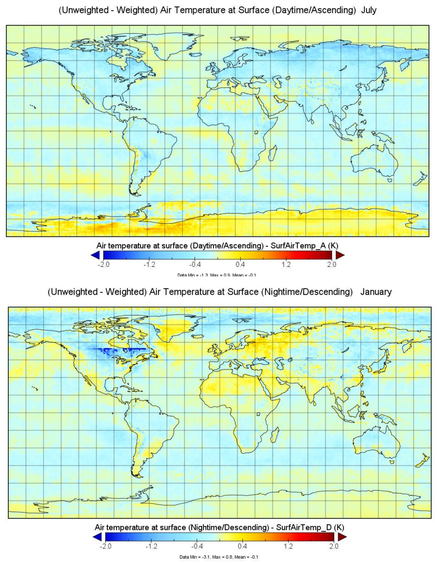
Two types of monthly product and multi-year monthly mean climatology are generated and compared. The **weighted** multi-year monthly mean climatology is added to Giovanni test server to demonstrate the AIRS climatology and anomaly applications.

Weighted vs Unweighted Monthly Surface Temperature of January and July 2010

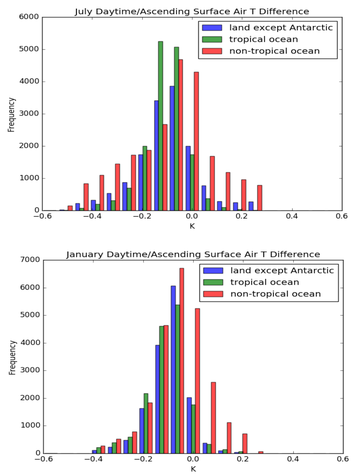


- There is a consistent, notable, difference between the unweighted and the weighted monthlies, with the largest differences for Surface Skin T around 8 K and for Surface Air T around 5 K. The root mean square difference over global is up to 0.72 K.
- The global means of arithmetic difference (unweighted – weighted) are always negative, with most values between -0.1K to -0.2 K. It shows the weighted monthlies are warmer than unweighted ones, which is likely because the weighted averaging gives more weight to clear days, which are generally warmer than cloudy days.
- The Surface Skin T maps overall show higher temperature differences than the Surface Air T maps, which might be explained by the higher heating rate that land has compared to air.
- Even though the unweighted monthlies are colder than the weighted ones globally, they are consistently warmer near the winter polar regions (July: South Pole; January: North Pole).

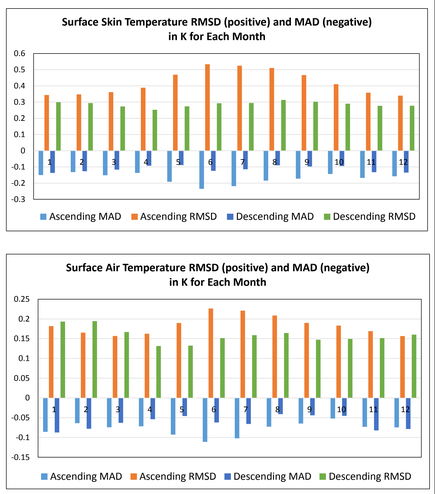
Weighted vs Unweighted 14-year Mean of Monthly Surface Temperature



Daytime/Ascending Surface Air T Difference Histogram for July (top) and January(bottom)



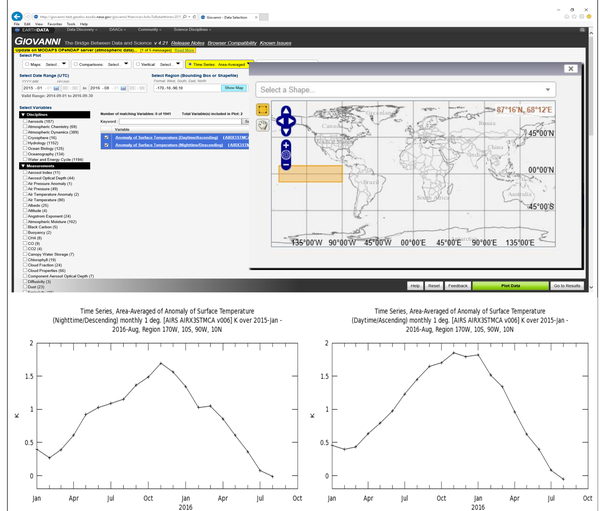
Mean Arithmetic Difference (MAD) and Root Mean Square Difference (RMSD) for Each Month



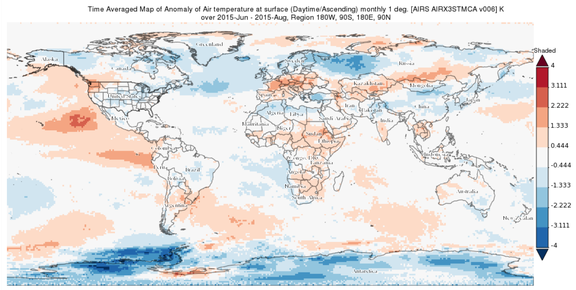
- Differences between the climatology created as 14-year means of unweighted and weighted monthly products show similar regional differences when compared to the monthly maps. With confidence larger than 95%, the differences are within +/-0.5 K.
- The weighted climatology is warm-biased (negative differences), which is consistently contributed mostly by Land and Tropical Oceans throughout the year. The global mean difference seems to peak during the boreal summer (-0.1, -0.2 K for surface air and skin, respectively).
- Most values of the global root mean square difference (unweighted – weighted) are between 0.15 K to 0.25 K for Surface Air T and 0.3 K to 0.5 K for Surface Skin T.

Applications on Giovanni

The 14-year means of weighted monthly surface air and surface skin temperatures have been deployed as a climatology on the Giovanni test server, along with their anomalies. The plots below demonstrate two use cases: the 2015-2016 El Niño event and June – August 2015 global surface temperature anomaly.



2015-2016 El Niño event: Time series plots of the sea surface temperature anomaly over the tropical central and eastern Pacific Ocean show remarkably warmer water from August 2015 to March 2016.



June – August 2015 surface air temperature anomaly: warming and cooling occurred in different regions.

Summary

- This study shows that the monthly products generated by two averaging methods have consistent and notable differences, hence two types of multi-year mean climatology. More research needs to be done for creating the climatology product using 14 years of AIRS data.
- Once fully implemented on Giovanni, AIRS climatology and anomaly variables can be used for visualization and analysis by climate science and application communities, such as regional and global climate variation studies and El Niño events.

Contact Information

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